U.S. Fish & Wildlife Service

Recovery Outline for *Lupinus sulphureus* ssp. *kincaidii* (Kincaid's lupine)

March 2006

Common Name	Kincaid's lupine
Scientific Name	*Lupinus sulphureus* ssp. *kincaidii*
Listing Status and Date	Threatened; January 25, 2000 (U.S. Fish and Wildlife Service 2000) Critical habitat proposed; November 2, 2005 (U.S. Fish and Wildlife Service 2005)
Lead Agency/Region	U.S. Fish and Wildlife Service, Region 1
Lead Field Office	Oregon Fish and Wildlife Office 2600 SE 98th Avenue, Suite 100 Portland, Oregon 97266 503-231-6179

Purpose of the Recovery Outline: This document lays out a preliminary course of action to ensure the survival and recovery of *Lupinus sulphureus* ssp. *kincaidii* (Kincaid's lupine). It is meant to serve as interim guidance to direct recovery efforts and inform consultation and permitting activities until a comprehensive draft recovery plan has been completed. A multi-species recovery plan for the listed prairie species of western Oregon and southwest Washington is in preparation by the Oregon Fish and Wildlife Office; this plan will cover *Lupinus sulphureus* ssp. *kincaidii* and five other listed species (Fender's blue butterfly [*Icaricia icariodes fenderi*], *Erigeron decumbens* var. *decumbens* [Willamette daisy], *Lomatium bradshawii* [Bradshaw's

lomatium], *Sidalcea nelsoniana* [Nelson's checker-mallow], and *Castilleja levisecta* [golden paintbrush]). The draft plan will likely be completed for public review in late 2006. However, we will consider any new information or comments that members of the public may wish to offer in response to this outline during the recovery planning process. For more information on Federal recovery efforts for *Lupinus sulphureu*s ssp. *kincaidii*, or to provide additional comments, interested parties may contact the lead field office at the above address or telephone number.

Scope of Recovery and Available Information: The recovery effort addressed by this outline applies only to *Lupinus sulphureu*s ssp. *kincaidii*. It provides a general overview of the available information concerning *Lupinus sulphureu*s ssp. *kincaidii*, presents a recovery goal and recovery objectives, and identifies immediate and longer-term actions, along with a tentative time line for the actions, to achieve expeditious recovery of *Lupinus sulphureu*s ssp. *kincaidii* in the wild. Some of the available information addressing certain issues, such as the effect of various habitat management techniques and development of a standardized population monitoring protocol, is currently preliminary or incomplete. An aim of the *Lupinus sulphureu*s ssp. *kincaidii* recovery effort is to gather or generate new information to help clarify these issues, as feasible, and to incorporate any new information into recovery strategies as it becomes available.

I. Overview

A. BIOLOGICAL ASSESSMENT

1. Species Description and Life History

*Lupinus sulphureu*s ssp. *kincaidii* is an herbaceous perennial in the pea family (Fabaceae). Flowering begins in April and extends through June. As the summer dry season arrives, *Lupinus sulphureu*s ssp. *kincaidii* becomes dormant, and is completely senescent by mid-August (Wilson *et al.* 2003). Pollination is largely accomplished by small native bumblebees (*Bombus mixtus* and *B. californicus*), solitary bees (*Osmia lignaria*, *Anthophora furcata*, *Habropoda* sp., *Andrena* spp., *Dialictus* sp.) and occasionally, European honey bees (*Apis mellifera*) (Wilson *et al.* 2003). Insect pollination appears to be critical for successful seed production (Wilson *et al.* 2003).

*Lupinus sulphureu*s ssp. *kincaidii* is able to spread extensively through vegetative growth, although it does not appear to actually reproduce (*i.e.*, form new, physiologically independent individuals) except by sexual means (Kaye and Kuykendall 1993, Gisler 2004). Individual clones can be several centuries old (Wilson *et al.* 2003), and become quite large with age, producing many flowering stems. Excavations and morphological patterns suggest that plants 10 meters (33 feet) or more apart can be interconnected by below-ground stems, and that clones can exceed 20 meters (66 feet) across (Wilson *et al.* 2003). As part of a genetic evaluation, collections taken from small populations of *Lupinus sulphureu*s ssp. *kincaidii* at the Baskett Slough National Wildlife Refuge were found to be genetically identical, indicating that the population consists of one or a few large clones (Liston *et al.* 1995).

*Lupinus sulphureu*s ssp. *kincaidii* is vulnerable to seed, fruit and flower predation by insects, which may limit the production of seeds. Seed predation by bruchid beetles (Coleoptera: Bruchidae) and weevils (Coleoptera: Curculionidae) has been documented (Kaye and Kuykendall 1993, Kuykendall and Kaye 1993). Floral and fruit herbivory by larvae of the silvery blue butterfly (*Glaucopsyche lygdamus columbia*) has also been reported (Kuykendall and Kaye 1993, Schultz 1995). The vegetative structures of *Lupinus sulphureu*s ssp. *kincaidii* support a variety of insect herbivores, including root borers, sap suckers, and defoliators (Wilson *et al.* 2003). *Lupinus sulphureu*s ssp. *kincaidii* is the primary larval host plant of the endangered Fender's blue butterfly (Wilson *et al.* 2003). Female Fender's blue butterflies lay their eggs on *Lupinus sulphureu*s ssp. *kincaidii* plants in May and June; the larvae hatch several weeks later and feed on the plant for a short time before entering an extended diapause, which lasts until the following spring (Schultz *et al.* 2003). *Lupinus sulphureu*s ssp. *kincaidii*, like other members of the genus *Lupinus*, is unpalatable to vertebrate grazers. *Lupinus sulphureu*s ssp. *kincaidii* forms root nodules with an unidentified bacterial symbiont, and also has vesicular-arbuscular mycorrhizae (a type of symbiotic fungus that occurs in association with the plant roots), which may enhance the plant's growth (Wilson *et al.* 2003).

2. Historical and Current Population Status

*Lupinus sulphureu*s ssp. *kincaidii* is found in dry upland prairies from Lewis County, Washington, in the north, south to the foothills of Douglas County, Oregon; however, most of the known and historical populations are found in Oregon's Willamette Valley (Figure 1). *Lupinus sulphureu*s ssp. *kincaidii* is currently known at about 57 sites, comprising about 160 hectares (395 acres) of total coverage (Kaye and Kuykendall 1993, Wilson *et al.* 2003). Until the summer of 2004, *Lupinus sulphureu*s ssp. *kincaidii* was known in Washington from just two extant populations, in the Boistfort Valley in Lewis County, more than 160 kilometers (100 miles) from the nearest population in the Willamette Valley. In 2004, 2 small populations were found at Drew's Prairie and Lacamas Prairie to the east of the Boistfort Valley in Lewis County; only 1 plant was observed at Drew's Prairie, and more than 40 plants were found at Lacamas Prairie (Caplow and Miller 2004; T. Thomas, U.S. Fish and Wildlife Service, pers. comm. 2006). Before Euro-American settlement of the region, *Lupinus sulphureu*s ssp. *kincaidii* was likely well distributed throughout the prairies of western Oregon and southwest Washington; today, habitat fragmentation has resulted in existing populations that are widely separated by expanses of unsuitable habitat. Monitoring the size of *Lupinus sulphureu*s ssp. *kincaidii* populations is challenging because its pattern of vegetative growth renders it difficult to distinguish individual plants (Wilson *et al.* 2003).

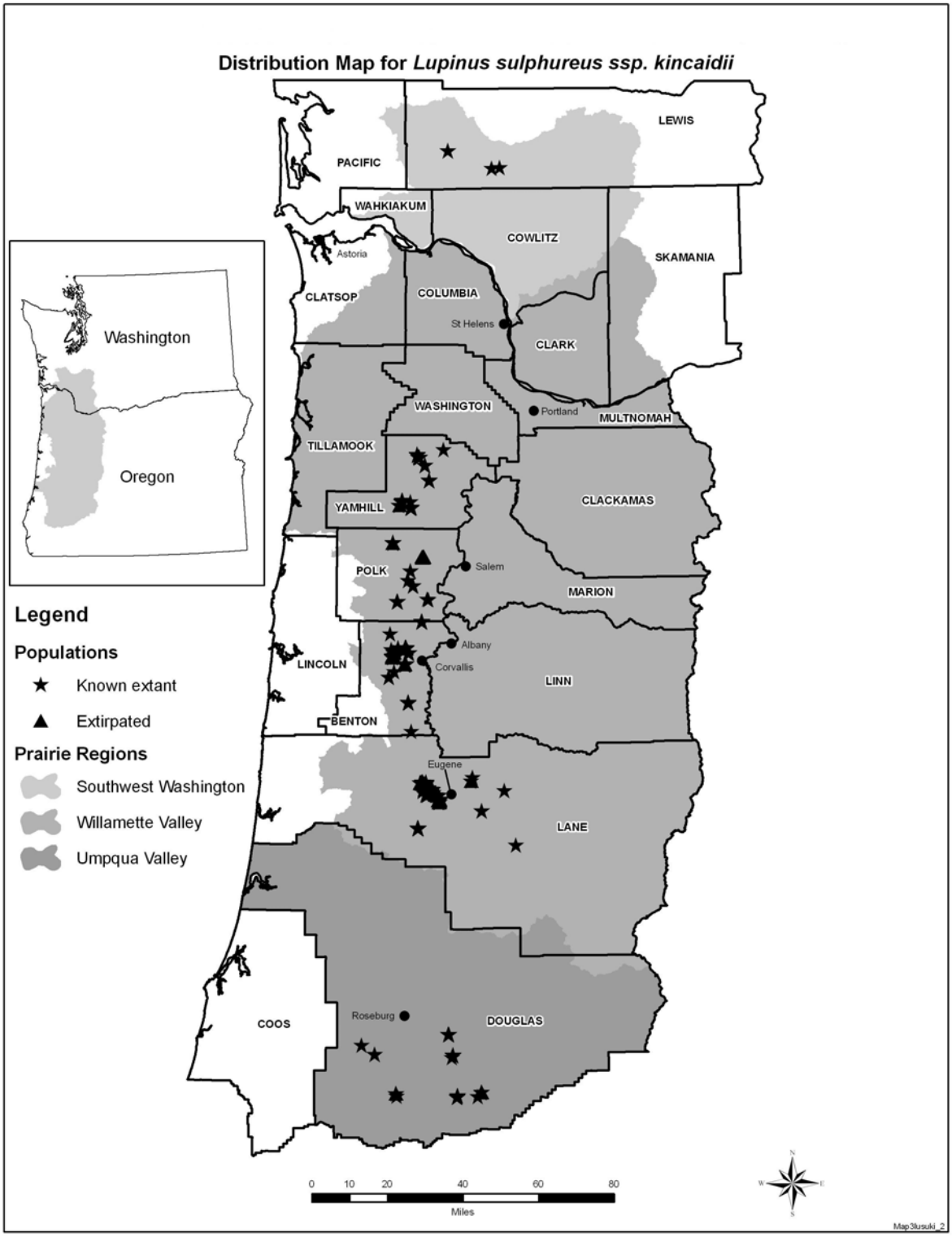


Figure 1. Distribution of *Lupinus sulphureus* ssp. *kincaidii.*

3. Habitat Description and Landownership

The native prairies of western Oregon and southwest Washington are among the most endangered ecosystems in the United States (Noss *et al.* 1995). Many prairie plant and animal species, including *Lupinus sulphureu*s ssp. *kincaidii*, have declined with the loss and degradation of the native prairies. Although once widespread in the region, today prairies "… are invariably small, moderately to heavily disturbed, and geographically disjunct" (Altman *et al.* 2001). Moist winters, dry summers and gentle topography are necessary to produce a prairie, but prairies will only persist when regular fire or flooding prevent succession to woody vegetation. Disturbances can be natural, such as wildfire, although most present day disturbances are anthropogenic (*e.g.*, prescribed fire or mowing). In the absence of regular disturbance, the prairies are overtaken by shrubs and trees, ultimately allowing succession to forest habitats, shading and crowding out the open grasslands and the species that depend on them. Recovery of *Lupinus sulphureu*s ssp. *kincaidii* will depend on our ability to restore prairie habitats, and the processes that maintain them, across the range of the species.

In the Willamette Valley and southwest Washington, *Lupinus sulphureu*s ssp. *kincaidii* is found on upland prairie remnants where the species occurs in small populations at widely scattered sites. Common native species typically associated with *Lupinus sulphureu*s ssp. *kincaidii* include: *Festuca roemeri* (Roemer's bunchgrass), *Danthonia californica* (California oat-grass), *Calochortus tolmiei* (Tolmie's mariposa lily), *Eriophyllum lanatum* (common woolly sunflower), and *Fragraria virginiana* (wild strawberry). The species appears to prefer heavier, generally well-drained soils and has been found on 48 soil types, typically Ultic Haploxerolls, Ultic Argixerolls, and Xeric Palehumults (Wilson *et al.* 2003).

In Douglas County, Oregon, *Lupinus sulphureu*s ssp. *kincaidii* appears to tolerate more shaded conditions, where it occurs at sites with canopy cover of 50 to 80 percent (Barnes 2004). In contrast to the open prairie habitats of the more northerly populations, in Douglas County, tree and shrub species dominate the sites, including *Pseudotsuga menziesii* (Douglas-fir), *Quercus kelloggii* (California black oak), *Arbutus menziesii* (Pacific madrone), *Pinus ponderosa* (ponderosa pine), *Calocedrus decurrens* (incense cedar), *Arctostaphylos columbiana* (hairy manzanita), and *Toxicodendron diversilobum* (poison oak).

In contrast to historical ecosystem composition, invasive nonnative species are a significant component of *Lupinus sulphureu*s ssp. *kincaidii* habitat today. Common invasives include: *Arrhenatherum elatius* (tall oatgrass), *Brachypodium sylvaticum* (slender false brome), *Dactylis glomerata* (orchard-grass), *Festuca arundinacea* (tall fescue), *Pteridium aquilinum* (bracken fern), *Rubus discolor* (Himalayan blackberry), and *Cytisus scoparius* (Scotch broom) (Wilson *et al.* 2003).

Lupinus sulphureus ssp. *kincaidii* habitat is in Federal ownership at the U.S. Fish and Wildlife Service's William L. Finley National Wildlife Refuge, the Army Corps of Engineers' Fern Ridge Reservoir, Bureau of Land Management units in Lane and Douglas Counties, and the Umpqua National Forest; local government and conservation organizations own habitat for the species at The Nature Conservancy's Willow Creek Preserve and at Oregon State University's Butterfly

Meadows in the McDonald State Forest, as well as an easement held by the Greenbelt Landtrust in Benton County.

4. Summary Biological Assessment

Populations of *Lupinus sulphureus* ssp. *kincaidii* are distributed throughout the species' historical range, although many populations are in need of conservation-oriented management to restore native prairie values. Controlling exotic plant species continues to be a major problem at most of the occupied sites. Additionally, the early seral habitat required by the species is threatened by succession, which contributes to ongoing management problems at most sites. At sites that are not being managed, *Lupinus sulphureus* ssp. *kincaidii* populations are exhibiting a downward trend. The remaining populations of *Lupinus sulphureus* ssp. *kincaidii* are small and isolated from one another, and recent research indicates the species is likely suffering from inbreeding depression.

B. THREATS ASSESSMENT

1. Listing Factors/Primary Threats to the Species

The primary threats to *Lupinus sulphureus* ssp. *kincaidii* are habitat loss, competition from nonnative plants, and elimination of historical disturbance regimes (Wilson *et al.* 2003). A description of each of these threats was presented in the final listing rule (U.S. Fish and Wildlife Service 2000). The recovery team and a group of experts familiar with the rare species and habitats in the region reviewed the current threats to *Lupinus sulphureus* ssp. *kincaidii* at each known site. They identified 16 distinct threats to *Lupinus sulphureus* ssp. *kincaidii*; each threat is described below, and is classified according to the 5 listing/delisting factors identified in section 4 of the Endangered Species Act (16 U.S.C. 1531 *et seq*.):

A. The present or threatened destruction, modification, or curtailment of its habitat or range.

1. **Adjacent land use practices**. Exogenous impacts from nearby lands, which could include herbicide or insecticide drift, spreading invasive or noxious weeds, escaped grazing animals, etc., which degrades prairie habitats by reducing the viability of remnant populations of prairie species.

2. **Hydrologic alterations**. Changes in landforms may modify the natural hydrology of a site; examples would include ditching or draining a wet prairie, thereby altering the annual duration of soil saturation, which in turn affects the species composition of the site.

3. **Invasive species.** Invasive nonnative species are a threat in virtually all known prairie remnants in the region. Invasive species dramatically change the structure of prairies, often forming tall, dense patches that shade out the natives, and compete for water and nutrients (Wilson et al. 2003). Common invasive species include *Arrhenatherum elatius, Brachypodium sylvaticum, Dactylis glomerata, Festuca arundinacea, Holcus lanatus* (common velvetgrass), *Phalaris arundinacea* (reed canarygrass), *Rubus discolor, Rosa eglanteria* (sweetbriar rose), and *Cytisus scoparius*.

4. **Isolation / fragmentation.** The increasing isolation and fragmentation of the remaining habitat patches as a result of the destruction of prairie habitats throughout the region has resulted in smaller population sizes, loss of genetic diversity, reduced gene flow among populations, disruption of metapopulation structure, and increased susceptibility to local population extirpation caused by environmental catastrophes.

5. **Road development / maintenance.** *Lupinus sulphureu*s ssp. *kincaidii* occurs in many small, fragmented populations, many of which are adjacent to roads. Routine roadside maintenance generally involves herbicide application or mowing, which reduces or even eliminates populations.

6. **Timber harvest / silviculture / logging.** When sites are prepared for tree planting, soil disturbance and herbicide application are common activities, which may negatively affect adjacent prairie habitats. Establishment of tree farms immediately adjacent to prairies will eventually shade out some habitat, and may also increase the effects of fragmentation, if insect pollinators are unable to travel through forested habitat. Ultimately, tree harvest also causes intense habitat disturbance and may reduce the size or quality of adjacent prairies.

7. **Wildfire / burning.** Wildfires and intentional burning can be a negative force if applied at the wrong time of year, such as before the end of the growing season, if the fire destroys *Lupinus sulphureu*s ssp. *kincaidii* plants before they senesce and set seed for the next growing season.

B. Overutilization for commercial, recreational, scientific, or educational purposes.

8. **Field research activities.** Increasing our knowledge of prairie ecology is vital to the successful restoration of *Lupinus sulphureu*s ssp. *kincaidii*; however, research itself can be a threat. Increased foot traffic in fragile habitats may result in crushing sensitive plants, collection of specimens may further reduce small population sizes, seeds of invasive plants may be carried in on boots or equipment, etc.

9. **Recreation**. As attractive open spaces in a largely forested region, prairies attract human recreation, which can have negative effects. Off-road vehicles, hikers, cyclists and horses may crush or uproot plants, seeds of invasive species may be spread by vehicle tires and horse manure, etc.

C. Disease or predation.

10. **Herbivores / predators.** Herbivory is a part of the natural life cycle of prairie plants. It may become a threat, however, when populations are small, and loss of even a very few individuals affects the viability of the population. In some cases, prolific populations of native wildlife such as deer, gophers, and voles have had serious negative impacts to small plant populations.

11. **Livestock grazing.** Grazing removes vegetative and reproductive plant structures, which can be destructive if it occurs during the growing season. Depending on the intensity of the grazing, and the type of livestock, the effect can also include substantial disturbance of the substrate. Grazers also can increase the spread of nonnative plant seeds into native habitats.

D. The inadequacy of existing regulatory mechanisms.

12. **Habitat vandalism**. Vandalism, defined as deliberate destruction of individuals or habitat, occasionally occurs when rare species cause unpopular restrictions on use of public or private lands; although not a common occurrence, vandalism could further reduce habitat function and destroy individual plants or animals.

E. Other natural or manmade factors affecting its continued existence.

13. **Succession to native woody plants.** Among the most urgent threats to western prairies, succession to native shrublands or forest occurs when the historical prairie disturbance regime has been suppressed. Common native species that invade and ultimately take over prairie habitats in the absence of periodic disturbance include: *Crataegus douglasii* (black hawthorn), *Fraxinus latifolia* (Oregon ash), *Quercus garryana* (Oregon white oak), *Pseudotsuga menziesii* and *Toxicodendron diversilobum*.

14. **Impaired ecological functions.** Frequently an effect of fragmentation and isolation, impaired ecological function occurs when remnant prairie patches become too small to sustain a breeding population, and when inter-patch distance exceeds the dispersal abilities of invertebrate pollinators of plants. The collapse or disruption of these processes may ultimately destroy remnant prairie patches.

15. **Small population size / low genetic variability.** Again, a frequent effect of fragmentation and isolation, small populations may be at risk of inbreeding depression; as patches get smaller and more separated from adjacent populations, the local pool of genetic material shrinks, potentially resulting in a loss of resilience to environmental change. Small populations are also at risk of extirpation due to stochastic events, such as unusually wet or dry years, unseasonal fires, etc.

16. **Pesticide use on-site.** Herbicides and insecticides, if not carefully applied, may have direct impacts to sensitive prairie species, or may have indirect impact through damage to host plants or pollinators; in either case, the effects of improperly applied pesticides may further reduce population size.

2. Summary Threats Assessment

Habitat loss from a wide variety of causes (*e.g.*, urbanization, agriculture, silvicultural practices, and roadside maintenance) has been the single largest factor in the decline of *Lupinus sulphureu*s ssp. *kincaidii* (U.S. Fish and Wildlife Service 2000). Land development and alteration in the prairies of western Oregon and southwest Washington have been so extensive that the remaining

populations are relegated to small, isolated patches of habitat. Habitat loss is likely to continue as private lands are developed; at least 49 of 54 sites occupied by *Lupinus sulphureu*s ssp. *kincaidii* in 2000 at the time of listing occurred on private lands and are at risk of being lost unless conservation actions are implemented (U.S. Fish and Wildlife Service 2000).

Habitat fragmentation and isolation of small populations may be causing inbreeding depression in *Lupinus sulphureu*s ssp. *kincaidii*. The subspecies was likely widespread historically, frequently outcrossing throughout much of its range, until habitat destruction and fragmentation severely isolated the remaining populations (Liston *et al.* 1995). There is some evidence of inbreeding depression, which may result in lower seed set (Severns 2003). Hybridization between *Lupinus sulphureu*s ssp. *kincaidii* and *Lupinus arbustus* (longspur lupine) has been detected at Baskett Slough National Wildlife Refuge (Liston *et al.* 1995).

Invasion of the habitat by nonnative plants has resulted in severe degradation of prairie habitat quality throughout the range of *Lupinus sulphureu*s ssp. *kincaidii*. Nonnative plants often form dense monocultures, which compete for space, water, and nutrients with the native prairie species, and ultimately inhibit the growth and reproduction of *Lupinus sulphureu*s ssp. *kincaidii* by shading out the plants (Wilson *et al.* 2003).

Prairies require frequent disturbances to hold back the natural succession of trees and shrubs. Before settlement by Euro-Americans, the regular occurrence of fire maintained the open prairie habitats essential to *Lupinus sulphureu*s ssp. *kincaidii*. The loss of a regular disturbance regime, primarily fire, has resulted in the decline of prairie habitats through succession by native trees and shrubs, and has allowed the establishment of numerous nonnative grasses and forbs. When this species was listed, we estimated that 83 percent of upland prairie sites were succeeding to forest in the range of *Lupinus sulphureu*s ssp. *kincaidii* (U.S. Fish and Wildlife Service 2000).

C. CONSERVATION ASSESSMENT

Active research efforts have focused on restoring the essential components of *Lupinus sulphureu*s ssp. *kincaidii* habitat by mimicking the historical disturbance regime with the application of prescribed fire, mowing, and manual removal of weeds. Research and habitat management programs for *Lupinus sulphureu*s ssp. *kincaidii* have been implemented at several sites, including Baskett Slough National Wildlife Refuge and The Nature Conservancy's Willow Creek Preserve (Wilson *et al.* 2003). Prescribed fire and mowing before or after the growing season has been effective in reducing the cover of invasive nonnative plants; following treatments, *Lupinus sulphureu*s ssp. *kincaidii* has responded with increased leaf and flower production (Wilson *et al.* 2003). Research has also been conducted on seed germination, propagation and reintroduction of *Lupinus sulphureu*s ssp. *kincaidii* (Kaye and Kuykendall 2001a, 2001b; Kaye and Cramer 2003; Kaye *et al.* 2003). Seeds of this species have been banked at the Berry Botanic Garden in Portland, Oregon (Berry Botanic Garden 2005).

Populations of *Lupinus sulphureus* ssp. *kincaidii* occur on public lands or lands that are managed by a conservation organization at the U.S. Fish and Wildlife Service's William L. Finley National Wildlife Refuge, the Army Corps of Engineers' Fern Ridge Reservoir, Bureau of Land

Management units in Lane and Douglas Counties, the Umpqua National Forest, The Nature Conservancy's Willow Creek Preserve, an easement held by the Greenbelt Landtrust in Benton County, and at a small portion of Oregon State University's Butterfly Meadows in the McDonald State Forest. All of these parcels have some level of management for native prairie habitat values.

Critical habitat was proposed on November 2, 2005 (U.S. Fish and Wildlife Service 2005). Critical habitat units for *Lupinus suphureus* ssp. *kincaidii* have been proposed for Benton, Douglas, Lane, Polk, and Yamhill Counties, Oregon, and Lewis County, Washington. The primary constituent elements of critical habitat are the habitat components that provide: (1) early seral upland prairie or oak savanna habitat with a mosaic of low growing grasses, forbs, and spaces to establish seedlings or new vegetative growth, with an absence of dense canopy vegetation providing sunlight for individual and population growth and reproduction, and with undisturbed subsoils and proper moisture and protection from competitive invasive species; and (2) the presence of insect outcrossing pollinators, such as bumblebees (*Bombus mixtus* and *B. californicus*), with unrestricted movement between existing lupine patches, critical for successful lupine reproduction. Critical habitat does not include human-made structures existing on the effective date of the rule and not containing one or more of the primary constituent elements, such as buildings, aqueducts, airports, and roads, and the land on which such structures are located.

The U.S. Fish and Wildlife Service is developing a programmatic conservation agreement for *Lupinus sulphureus* ssp. *kincaidii* in Douglas County, Oregon, with the Roseburg Bureau of Land Management and the Umpqua National Forest. The objectives of the conservation agreement are: (1) to maintain stable populations of *Lupinus sulphureus* ssp. *kincaidii* in Douglas County by protecting and restoring habitat in each of the populations; (2) to reduce threats to the species to assure that viable populations of *Lupinus sulphureus* ssp. *kincaidii* in Douglas County will be maintained on Bureau of Land Management and Forest Service-managed lands; (3) to promote larger functioning metapopulations of *Lupinus sulphureus* ssp. *kincaidii*, with increased population sizes and genetic diversity, which in turn, promote long-term population viability and species conservation; and (4) to meet recovery criteria for the Douglas County recovery zone for *Lupinus sulphureus* ssp. *kincaidii*.

During the 2003 and 2004 fiscal years, the U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program funded seven projects in Benton, Polk, and Yamhill Counties, Oregon, that restored 115 hectares (285 acres) of upland prairie, oak savanna and wet prairie habitats; many of these projects may benefit *Lupinus sulphureus* ssp. *kincaidii* (A. Horstman, U.S. Fish and Wildlife Service, pers. comm. 2004).

Since the species was listed, the U.S. Fish and Wildlife Service's Oregon Fish and Wildlife Office has conducted 20 formal consultations under section 7 of the Endangered Species Act with Federal agencies for projects that may affect *Lupinus sulphureus* ssp. *kincaidii*. The goal of these interagency consultations has been to ensure that the species is not jeopardized, and to minimize the effects of projects that have Federal involvement.

II. Preliminary Recovery Strategy

A. RECOVERY PRIORITY NUMBER

*Lupinus sulphureu*s ssp. *kincaidii* is assigned a recovery priority number of 9 on a scale of 1C (highest) to 18 (lowest; the "C" indicates the potential for conflict with human economic activities), based on the moderate degree of threat, a high potential for recovery, and its status as a subspecies (USFWS 1983a,b).

B. RECOVERY STRATEGY

The recovery strategy, criteria, and actions proposed in this recovery outline are based on the following fundamental concepts for reducing the risk of extinction and ensuring, to the extent possible, the persistence of the species into the foreseeable future:

1. Reduce or eliminate the systematic threats to the species, as detailed in section I-B.
2. Reduce risk from stochastic processes (demographic, environmental, and genetic uncertainty) and natural catastrophes by:
    a. Ensuring that populations are at or above the estimated minimum viable population size; and
    b. Increasing the probability of persistence by ensuring the preservation of multiple populations managed in a metapopulation structure across its historical range (protective redundancy).
3. Conserve available genetic variability within the species to provide for both short-term fitness as well as the evolutionary potential for the species to adapt to changing conditions.
4. Provide for long-term viability of the species by:
    a. Protecting and securing habitat sufficient to support the requisite population sizes and maintain connectivity between local populations;
    b. Restoring and maintaining high quality, diverse prairie habitats dominated by native species through active management;
    c. Monitoring populations to ensure that population trends are stable or increasing and to provide feedback for adaptive management; and
    d. Seed banking in an appropriate repository to provide a back-up supply of genetic stock that represents as much of the available genetic diversity within the species as possible.

The strategy to achieve the recovery of *Lupinus sulphureu*s ssp. *kincaidii* is to restore and maintain multiple viable populations of the species by protecting, restoring, maintaining, and connecting, to the maximum extent practicable, the remaining fragments of prairie habitats or areas with potential for restoration to prairie habitats within its historical range. These areas should be restored to functional prairie ecosystems with management appropriate to approximate natural disturbance regimes and to restore and maintain a diversity of native species typical of these prairie communities. The primary threats to be addressed through this recovery strategy are habitat isolation and fragmentation, invasion by nonnative plant species, and succession.

C. GOAL AND OBJECTIVES

Lupinus sulphureus ssp. *kincaidii* is listed as threatened. The goal of the recovery program is to reduce the threats to the species to the point that it no longer requires the protections of the Endangered Species Act and may be removed from the Federal List of Endangered and Threatened Wildlife and Plants (delisted).

The objective of the recovery program is to achieve viable populations of *Lupinus sulphureu*s ssp. *kincaidii* distributed across its historical range in a series of multiple interconnected populations, or metapopulations. We consider a viable population to be one that has sufficient numbers and distribution of reproductive individuals so as to provide a high likelihood of persisting into the foreseeable future despite demographic, genetic, and environmental uncertainties, including random catastrophic events. To best approximate the historical natural conditions and distribution of *Lupinus sulphureu*s ssp. *kincaidii*, we have identified geographic recovery zones across its historical range and classified these zones into two tiers, Tier 1 and Tier 2. A Tier 1 recovery zone is one in which *Lupinus sulphureu*s ssp. *kincaidii* was historically abundant, and should therefore be held to a high standard for recovery. The minimum viable population for a Tier 1 recovery zone is estimated to be 10,000 individuals (based on input from the species experts on the recovery team and multiple references for estimating minimum viable population sizes [e.g., Lande and Barrowclough 1987; Shaffer 1987; Lande 1988, 1995; Ellstrand and Elam 1998 and references therein; Nunney and Campbell 1993]). Since *Lupinus sulphureus* ssp. *kincaidii* spreads by rhizomes and produces clones, it can be difficult to distinguish between individual plants, making accurate counts difficult. We have therefore determined that abundance of *Lupinus sulphureus* ssp. *kincaidii* should be measured by the total amount of cover (square meters of ground area covered by the species) rather than number of individual plants. We have defined 5,000 square meters (1.24 acres) of total cover of *Lupinus sulphureus* ssp. *kincaidii* as the minimum viable population size in a Tier 1 Recovery Zone. Tier 2 zones are those where the species has always occurred more infrequently, and thus has a lower target abundance for recovery.

D. RECOVERY CRITERIA

The species will be considered for delisting when all of the following conditions have been met:

1. **Distribution and number of metapopulations**. The distribution of the metapopulations should reflect the extent of the species' historical geographic distribution to the extent practicable. This will be achieved by conserving a minimum of 2 metapopulations within each of the Tier 1 Recovery Zones and 1 metapopulation within the Tier 2 Recovery Zones (Figure 2), for a total of 10 metapopulations across the range of *Lupinus sulphureu*s ssp. *kincaidii*.

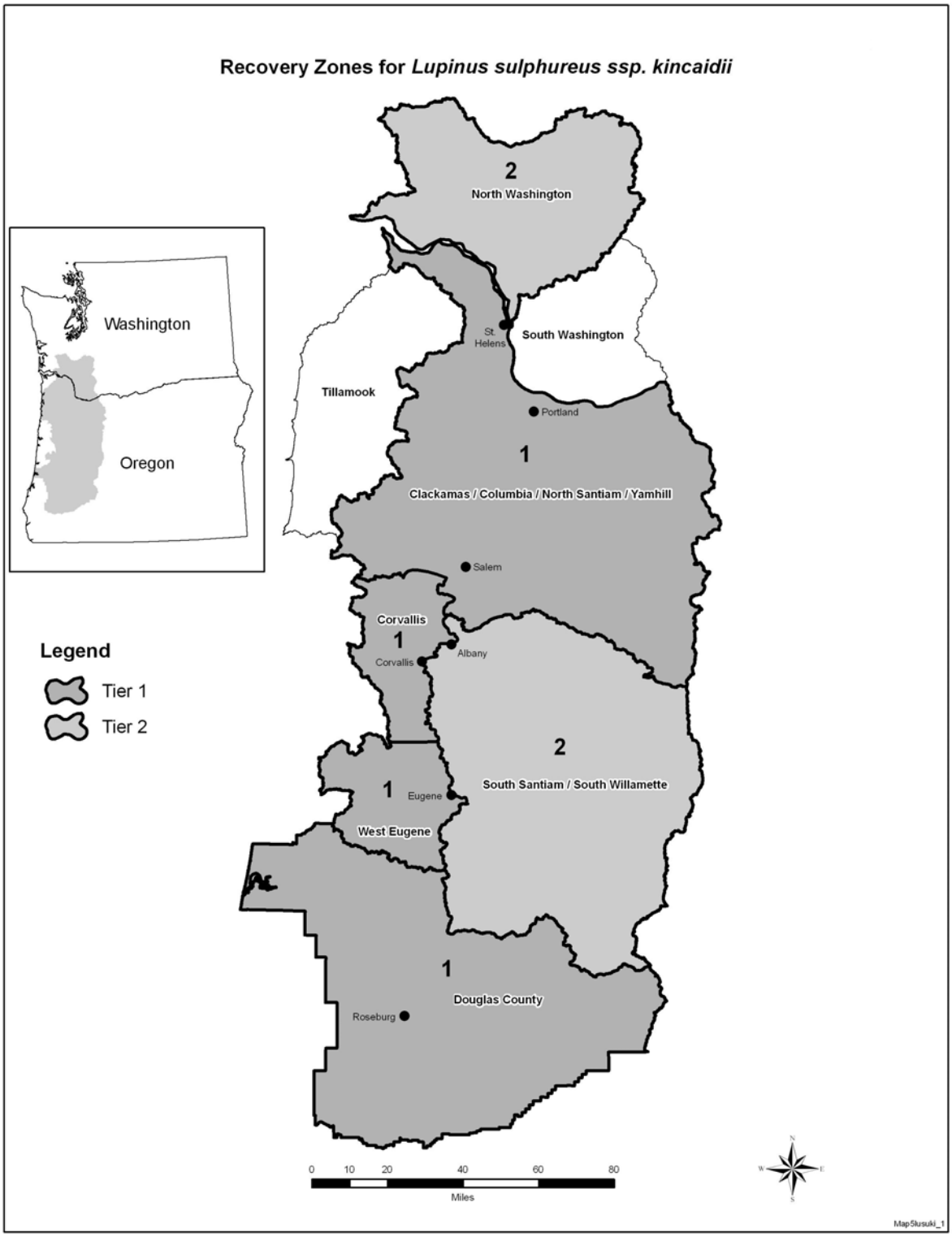


Figure 2. Recovery zones for *Lupinus sulphureus* ssp. *kincaidii.*

2. Number and size of metapopulations. For each metapopulation, a minimum abundance of individuals must be achieved. The abundance goal for a Tier 1 Recovery Zone is 5,000 square meters (1.24 acres) of cover of *Lupinus sulphureus* ssp. *kincaidii*, with a minimum of two metapopulations of 1,000 square meters (0.25 acre) cover each. For a Tier 2 Recovery Zone, the abundance goal is 2,500 square meters (0.6 acre) total cover of *Lupinus sulphureus* ssp. *kincaidii*, with at least one metapopulation that has at least 1,000 square meters (0.25 acre) of cover. Additional local populations may also contribute to the total abundance goal for each recovery zone, even if they are not considered to be a constituent subpopulation of a metapopulation. Such independent local populations must have at least 60 square meters (646 square feet) of cover to contribute to the recovery goal (Table 1; see Figure 3 for a schematic demonstration of this recovery concept).

3. Distribution and size of local populations within the metapopulations.

- **a.** A minimum of two or more local populations shall comprise each metapopulation, except in those rare cases where there is no historical evidence that more than one local population has ever existed within the recovery zone. Each of these local populations shall be distributed within the metapopulation separated by a distance no more than the maximum average foraging distance of the species' pollinator with the greatest foraging range. For *Lupinus sulphureus* ssp. *kincaidii*, the pollinator with the greatest foraging range is the European honey bee, known to travel up to 9,000 or 10,000 meters (5.6 to 6.2 miles) to forage (Beekman and Ratnieks 2000, Steffan-Dewenter and Kuhn 2003). Only occasional genetic exchange is required to maintain fitness in small populations (Mills and Allendorf 1996, Newman and Tallmon 2001, Wang 2004).
- **b.** Local populations that are considered as contributing to recovery must be composed of a minimum of 60 square meters (646 square feet) total cover. If possible, there should be sufficient area available for population growth and expansion into adjacent suitable habitat.
- **c.** The distribution of local populations should be targeted to achieve historical distribution patterns to the maximum extent practicable. Where this is not possible, a practicable approximation of historical distribution may be achieved through a combination of protection of extant local populations and reestablishment of known historical occurrences.

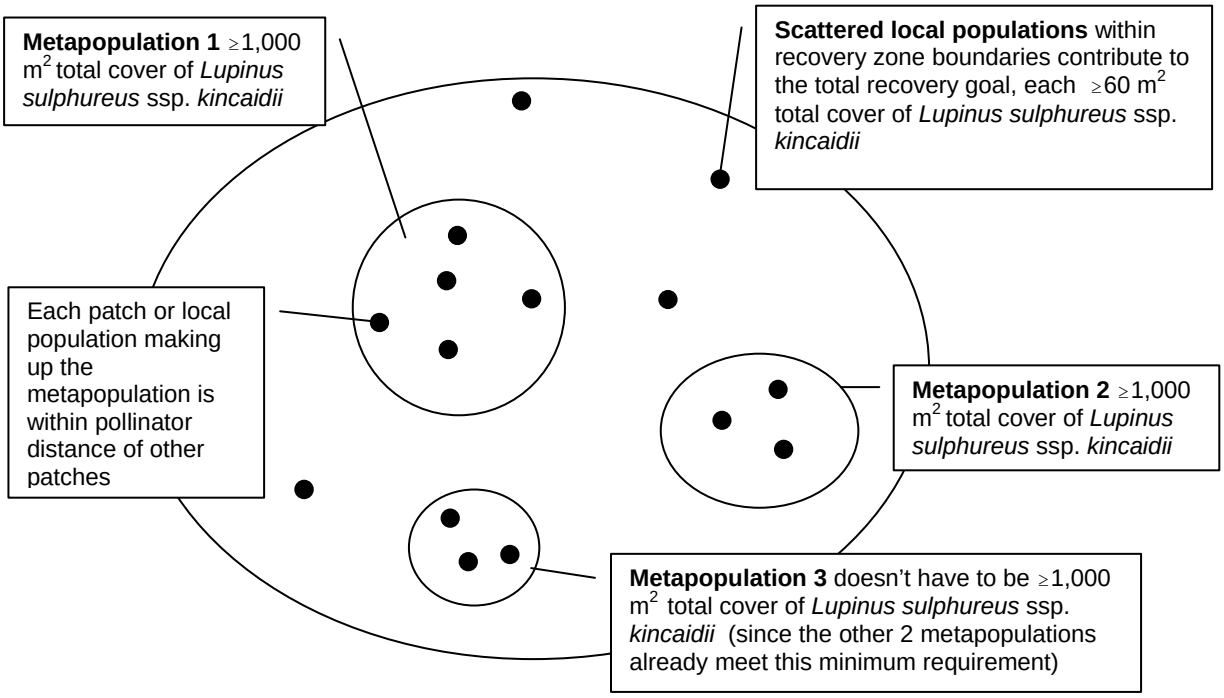
4. Population trend and evidence of reproduction. The abundance of *Lupinus sulphureus* ssp. *kincaidii* in the metapopulation (expressed as square meters of total cover) shall have been stable or increasing over a period of at least 10 years. Because we expect variability in annual population counts, we define a stable or increasing population as one that exhibits a least squares regression line with a slope greater than or equal to zero when the population counts are plotted against time over the period of 10 years in a linear regression model. Within each metapopulation, at least 70 percent of the constituent local populations should be stable or increasing over the same time frame. Local populations must show evidence of reproduction, such as flowering, seed set, or presence of seedlings.

Table 1. Summary of the population and distribution recovery goals for *Lupinus sulphureus* ssp. *kincaidii*, based on the two-tiered system of recovery zones.

Recovery Zones	**Minimum number of metapopulations per recovery zone**
Tier 1	
Yamhill/Columbia/Clackamas/North Santiam	2
Corvallis	2
West Eugene	2
Douglas County	2
Tier 2	
North and South Washington	1
South Santiam/South Willamette	1
Minimum Number of Metapopulations for Recovery	**10**
Estimated minimum viable population size (per recovery zone)	5,000 m^2 total cover (1.25 acres)
Minimum size of metapopulations	1,000 m^2 total cover (0.25 acre)
Minimum size of local populations	60 m^2 total cover (646 square feet)
Maximum distance between local populations within a metapopulation	9,000 meters (5.6 miles)

Figure 3. Schematic demonstrating the metapopulation recovery concept for *Lupinus sulphureus* ssp. *kincaidii*, using an example of a Tier 1 recovery zone.

A Tier 1 recovery zone has a recovery goal of 5,000 square meters (1.24 acres) total cover and requires a minimum of 2 metapopulations, each with greater than or equal to 1,000 square meters (0.25 acre) total cover. In this case, the recovery criteria are met through a combination of 3 metapopulations (of which 2 meet the minimum of at least 1,000 square meters cover each) and 4 scattered local populations (each of which must have at least 60 square meters (646 square feet), altogether totaling ≥ 5,000 square meters.



So for example, in this Tier 1 Recovery Zone, the abundance goals may be met through a combination of Metapopulation 1 with 2,000 square meters of cover, Metapopulation 2 with 1,800 square meters of cover, and Metapopulation 3, with 800 square meters of cover (4,600 square meters of total cover in metapopulations, each composed of smaller populations within pollinator distance of one another), plus an additional four independent local populations that each have a minimum of 60 square meters of cover (say that these local populations have 100, 60, 80, and 160 square meters each, respectively, totaling 400 square meters of cover), for an overall total of 5,000 square meters of cover of *Lupinus sulphureus* ssp. *kincaidii* within the recovery zone.

5. Habitat quality and diversity.

- **a. Prairie quality index.** At least 70 percent of the reserves (see definition in 6a, below) have a prairie quality index of 70 percent or better. The prairie quality index is calculated by adding up the cover values for each of the individual native prairie species (excluding woody species) present and dividing by the total cover value for all of the species present added together at the reserve (including woody species). This criterion may be relaxed for reserves in the Douglas County recovery zone, which appears to support populations in more shrubby and woody conditions, provided that all other criteria are met (populations stable or increasing, evidence of reproduction, etc.)
- **b. Reserve diversity.** An index of prairie diversity will be developed that accounts for the desired representation of various native plant species within each recovery zone.

6. Management status and control of threats to the species.

- **a. Security of habitat**. The habitat for the local populations making up each of the subject metapopulations must be owned or managed by a government agency or private conservation organization that identifies maintenance of the species and the prairie ecosystem upon which it depends as the primary management objective for the site, or the site must be protected by a permanent conservation easement or covenant that commits present and future landowners to the conservation of the species. Local populations that have been thus secured, support the minimum number of individuals (60 square meters [646 square feet]), and are within pollination distance of other such populations collectively contributing to the minimum viable population size of the metapopulation are referred to as "reserves."
- **b. Appropriate management.** Each reserve must be managed appropriately to ensure the maintenance or restoration of quality prairie habitat and to reduce or control the identified threats to the species sufficient to achieve Recovery Criteria 1 through 5. Management plans must be developed and implemented for all State- and federally-owned reserves. These management plans should include performance criteria by which to assess their effectiveness following implementation and to allow for adaptive management, as necessary.

7. Genetic material is stored in a facility approved by the Center for Plant Conservation. The stored genetic material in the form of seeds must represent the species' geographic distribution and genetic diversity.

8. A post-delisting monitoring plan and agreements to continue post-delisting monitoring are in place and ready for implementation at the time of delisting. Monitoring of populations following delisting will verify the ongoing recovery of the species and provide a means of assessing the continuing effectiveness of management actions.

Note: Although estimates of the minimum population sizes are provided by which to gauge probable long-term viability of the populations, it should be recognized that the numbers of individuals of disturbance-adapted species are likely to vary widely from year-to-year depending upon environmental conditions. The recovery team has therefore recommended that the appropriate management of the habitat for restoration and maintenance of native prairie as

assessed by measures of prairie diversity and quality is of greater importance than the absolute total numbers of individuals present in each recovery zone. In other words, the suggested total minimum population numbers for *Lupinus sulphureu*s ssp. *kincaidii* are provided to serve as a general index of population viability when considered in conjunction with the other criteria for prairie management, connectivity, quality, and diversity, rather than as an absolute stand-alone threshold to be met for recovery.

F. RECOVERY ACTIONS

The recovery actions identified below are taken from the preliminary draft of the Draft Recovery Plan for the Prairie Species of Western Oregon and Southwest Washington (U.S. Fish and Wildlife Service, in prep.).

1. Preserve, restore, and manage existing populations and habitat of *Lupinus sulphureus* ssp. *kincaidii*.
    a. Evaluate the status of extant populations.
    b. Survey historical extirpated sites and suitable habitat near these sites to determine if any of these populations may still persist.
    c. Select, protect, and manage reserve population sites.
    d. Evaluate protected status of reserve populations.
    e. Secure conservation or management agreements for reserve populations that are not yet protected.
    f. Develop site-specific management plans.
    g. Manage reserve populations to address threats and increase populations.
    h. Augment populations, as necessary.
    i. Restore connectivity between populations.
2. Develop and implement a standardized population monitoring protocol.
3. Monitor prairie quality and diversity at all reserve sites.
4. Collect and bank seeds.
5. Identify reintroduction sites.
6. Develop and implement outplanting protocol.
7. Reintroduce populations and restore habitat, as necessary, to meet recovery goals.
8. Manage and monitor reintroduced populations.
9. Identify and implement further research needed for the conservation of the species.
10. Evaluate the effectiveness of different prairie management techniques.
11. Evaluate genetic variability within and between populations, if deemed necessary.
12. Model viability of metapopulations based on new demographic data.
13. Monitor effectiveness of management actions and apply adaptive management practices, as appropriate.
14. Develop post-delisting monitoring plans prior to delisting.

III. Preplanning Decisions

A. PLANNING APPROACH

A Draft Recovery Plan for the Prairie Species of Western Oregon and Southwest Washington is being prepared by Service biologists with assistance from an appointed recovery team. A preliminary draft is nearly complete, and will be released for peer review soon. A draft recovery plan will likely be released for public review in late 2006.

B. INFORMATION MANAGEMENT

The administrative record for the recovery outline and the draft recovery plan is on file at the Oregon Fish and Wildlife Office.

C. RECOVERY PLAN SCHEDULE

Regional Office Review Draft	Review Draft received January 30, 2006
Peer Review of Draft Plan	April 2006
Public Review Draft	Summer 2006
Public Comment Period	60 days following release of draft recovery plan
Final Recovery Plan	1 year after release of public review draft

D. STAKEHOLDER INVOLVEMENT

Key stakeholders:

- U.S. Bureau of Land Management
- U.S. Army Corps of Engineers
- U.S. Forest Service
- Oregon Natural Heritage Program
- Washington Department of Natural Resources
- Oregon Department of Transportation
- City of Eugene
- Confederated Tribes of the Grand Ronde Community of Oregon
- U.S. Fish and Wildlife Service Willamette Valley National Wildlife Refuge Complex
- In addition, species experts from Oregon State University, Washington State University, Reed College, University of Montana, The Nature Conservancy and the Berry Botanic Garden have contributed to the draft recovery plan.

E. STAKEHOLDER INVOLVEMENT STRATEGY

Successful recovery of *Lupinus sulphureus* ssp. *kincaidii* will require the involvement of many stakeholders, including all levels of government, from Federal to local, private landowners, conservation organizations, research biologists, and more. The Service has assembled a diverse

group of species experts, land managers, regulators, and others (see the list of key stakeholders in D., above) to assist us in developing the Draft Recovery Plan for the Prairie Species of Western Oregon and Southwest Washington.

Approved:

Acting _____ 3/22/06

Regional Director, Region 1 Date
U.S. Fish and Wildlife Service

Citation

U.S. Fish and Wildlife Service. 2006. Recovery Outline for *Lupinus sulphureus* ssp. *kincaidii* (Kincaid's Lupine). Portland, Oregon. 23 pp.

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